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APPLICATION OF LANDSAT-2
TO THE MANAGEMENT OF DELAWARE'S
MARINE AND WETLAND RESOURCES

Dr. V. Klemas, D. Bartlett, W. Philpot, G. Davis *etc*
College of Marine Studies
University of Delaware

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A. PROBLEMS

Of the six objectives indicated in Section B, numbers 2, 3, 4 and 5 will be completed by December of this year. However, more work needs to be done on objectives 1 and 6. As outlined below, these two areas have yielded exceptionally good results, have very strong user interest, and will receive additional funding from NASA in order to bring the efforts to a proper conclusion. A 10-month extension with additional funding has been approved by NASA.

B. ACCOMPLISHMENTS

1. General

Studies of the Delaware Bay region with LANDSATS-1-and-2 have so far produced useful results for all six objectives outlined in the work statement. Status of each objective is shown in terms of percentage of tasks completed.

<u>Objective</u>	<u>Status</u>
1. Monitoring the dispersion and movement of ocean dump plumes. (Work Statement Tasks 1, 2, 3 and 4).	60%
2. Suspended sediment Concentration mapping (Work Statement Tasks 5, 6 and 7).	70%
3. Current circulation and boundary charting for a model which predicts the movement of oil slicks (Work Statement Tasks 8, 9, 10 and 11).	95%
4. Coastal land use and vegetation studies. (Work Statement Tasks 12, 13 and 14).	90%
5. Comparison of training site and spectral signature (with atmospheric correction) techniques for classifying coastal land cover and environmental impact. (Work Statement Task 15).	70%
6. Impact of Outer Continental Shelf development on the coastal zone of Delaware. (Work Statement Tasks 16, 17 and 18).	40%

Many of the results attained are presented in progress reports and recent publications. (Ref. 2, 3, 4, 5, 6 and 7). All of the problem areas shown

above have been identified as being urgent by key federal, state or local user groups.

2. Assessment of Potential Onshore Impact of Mid-Atlantic OCS Development.

Work was begun on planning the field investigations to the test sites, and a trip to the Santa Barbara site was completed. It was decided that the field work would be comprehensive, i.e. analyses of the total spectrum of OCS development and impact, not just land use impact, would be investigated. This will facilitate the acquisition of the maximum amount of relevant information, as well as provide the investigator the opportunity to evaluate personally the true impact condition. It was further decided that the field investigations should occur over a relatively long period of time. Instead of analyzing each site completely, as an entity onto itself, before proceeding to the next one, all the site will be checked and afterwards each will be analyzed separately. This method will maximize the benefits derivable by comparative analysis.

A procedure was established for conducting the field work. Prior to travel, contact will be made with people and/or agencies with a lead in evaluating OCS impact in their area. Upon arrival at the site the initial contact would be followed-up with data collection from these sources. Maximum use of their resources, personnel, and information will be made, especially in travelling to impacted areas within each site. After returning from travel, procedures will be evaluated and updated, if necessary, before beginning the next field investigation.

In the case of the Santa Barbara site, which was visited during the last week in May, the aforementioned procedure was adhered to. In early May, contact was made with Dr. John Estes and Mr. Steven Crouse, both in the Geography Department of the University of California at Santa Barbara. Both are intimately familiar with OCS development in the San Barbara channel.

3. Landsat Observations of Ocean Dump

Plume Movement and Dispersion

Eighteen LANDSAT images were analyzed to study the dispersion and movement of ocean dump plumes thirty-eight miles southeast of Cape Henlopen, Delaware, at the disposal site for waste discharged from a plant producing titanium dioxide. The discharge is a greenish-brown liquid containing up to 10% acidity (expressed as HCl) and 4% iron as iron chloride salts. The barge which transports this waste is capable of releasing one million gallons of the liquid upon radio-command from a towing tug. It makes several trips to the disposal site per month.

The current circulation data is being used to assess the movement and dispersion of the acid waste plumes together with wind and weather data. In general, it appears that rapid movement toward shore can occur primarily during storms, particularly northeasters. During such storms, however, the plume is rapidly dispersed and diluted. Therefore, the probability of an identifiable plume containing heavy concentrations of acid waste reaching the shore is quite low.

C. SIGNIFICANT RESULTS

1.) Imagery from LANDSAT-1 and LANDSAT-2 proved valuable in determining the location, type and extent of estuarine fronts under different tidal conditions. Neither ships nor aircraft alone could provide as complete, synoptic and repetitive an overview as did the satellites. Since estuarine fronts influence the movement of oil slicks and dispersion of other pollutants, clean-up operations depending on real-time use of oil slick movement prediction models will benefit not only from aircraft tracking the actual slicks but also from real-time satellite observations of surface currents and the location of frontal systems.

Dr. Estes has evaluated oil spills and their effects using remote sensor data since 1969 and Mr. Crouse, while an employee with Dames and Moore, worked on an environmental impact report addressing continued OCS operations in the Santa Barbara channel. This report was sponsored by the California State Lands Commission under authority of the California Environmental Quality Act and state land leasing regulations.

The findings of this report, combined with those from the Department of Interior's Environmental Impact Statement on OCS development in this area, seem to indicate that very little land use change has been caused in Santa Barbara by offshore oil operations. No processing occurs in lower Santa Barbara County and the oil is piped directly to Carpinteria, where onshore oil development has been conducted for many years.

Table 1.

Waste Plume Characteristics Derived from LANDSAT Imagery

Date	Hours After Dump	Lateral Extent (N.M.)	(N to S) Axis Orientation	Distance Between Centroids (N.M.)	Axis Orientation	Maximum Distance from Center of Dump Site (N.M.)	Axis Orientation
1) 10/10/72 (9h30)		10	155°	8.5	250°	10	285°
2) 10/27/72 (14h08)		5	260°	4	225°	5	225°
3) 1/25/73 (4h03)		5	120°	4.5	275°	8	285°
4) 4/07/73 (4h03)		8	110°	3	280°	5	295°
5) 5/13/73 (during)		1	105°	3	260°	3.5	260°
6) 10/22/73 (29h25)		14.5	225°	12	195°	15	205°
7) 10/23/73 (53h31)		14	200°	24.5	215°	27	210°
8) 4/20/74 (14h47)		7	145°	7	215°	8.5	185°
9) 5/26/74 (21h06)		7.5	145°	10.5	235°	13	235°
10) 11/04/74 (46h26)		7	240°	3.5	120°	6.5	90°
11) 8/19/75 (during)		7.5	120°	1.5	160°	4	13°
12) 8/28/75 (just after)		6	220°	1.5	270°	5.5	245°
13) 10/21/75 (6h35)		8	250°	3.5	185°	6	235°
14) 11/17/75 (8h16)		8	120°	2	160°	5	160°
15) 1/19/76 (6h10)		6.5	245°	2	245°	4.5	240°
16) 2/24/76 (9h10)		10	105°	4	135°	8	115°
AVERAGE		7.8	175.9°	5.3	206.4°	8.8	212.5°

2). The following results were obtained on the dump plume studies:

a. The frequency of the dumping made it possible for the LANDSAT satellite to image the waste plume in various stages of degradation, ranging from minutes to days after dump initiation. The long visual persistence has been explained by the formation of a suspended ferric floc. Spectrometric measurements indicate that upon combining with seawater the acid waste develops a strong reflectance peak in the 0.55 to 0.60 micron region, resulting in a stronger contrast in the MSS Band 4 than the other bands.

b. The predominant direction of movement of the waste plumes imaged by the LANDSAT satellite was to the southeast. This appears to be due to the fact that northeasterly winds produce stronger currents than those driven by southeasterly winds and by the thermohaline circulation. (See Table 1).

c. The average drift velocity for surface drogues and the waste plumes as observed by LANDSAT was about 0.5 knots. Drogues released at different depths frequently travelled along different paths, and at different speeds, indicating the presence of strong current shear. During stratified conditions the near-bottom drogues showed very little movement.

d. The water at the test site was highly stratified and stable in the summer and nearly homogeneous in the winter. A distinct thermocline was observed from June through August, at depths ranging from 43 to 103 feet. During most dumps the acid plume was unable to penetrate the thermocline and reach the bottom.

E. RECOMMENDATIONS

Order NOAA/EDS not to send LANDSAT-2 prints and transparencies with excessive cloud cover. Also action has been taken to decrease the size of our test site in order to conserve funding in our imagery accounts.

F. FUNDS

On schedule for Objectives 2, 3 and 4. Insufficient for Objectives 1, 5 and 6, as explained in Section A, until additional funding is obtained from NASA.

G. DATA USE

All ordered LANDSAT-2 tapes have been received so far. They have been evaluated and are currently being analyzed.

H. AIRCRAFT DATA

Aircraft overflights have been on time and on target. Some imagery has been received and more imagery is on order. One more overflight will be conducted in September of 1976.

I. PERSONNEL CHANGES

None.

D. PUBLICATIONS

1. Klemas, V., Invited presentation to Captain Jacques Cousteau and Dr. Philippe Cousteau on Ocean Current Measurement with Integrated Drogue-Aircraft-Satellite Systems, NASA Headquarters, Washington, D. C., October 6, 1975.
2. Klemas, V., Bartlett, D., Rogers, R., Coastal Zone Classification from Satellite Imagery. Photogrammetric Engineering and Remote Sensing, Journal of the American Society of Photogrammetry, Vol. 41, No. 3, April, 1975.
3. Klemas, V., Otley, M., Wethe, C., Rogers, R., ERTS-1 Studies of Coastal Water Turbidity and Current Circulation, American Geophysical Union 55th Annual Meeting, Washington, D. C., April 8-12, 1974.
4. Klemas, V., Tornatore, G., Whelan, W., A New Current Drogue for Monitoring Shelf Circulation, American Geophysical Union 56th Annual Meeting, Washington, D. C., June 16-20, 1975.
5. Klemas, V. and Bartlett, D., Application of ERTS-1 and Skylab to Coastal Zone Management, NASA Earth Resources Survey Symposium, Houston, June 8-13, 1975.
6. Klemas, V., Davis, G., Wang, H., Whelan, W., Tornatore, G., A Cost-Effective Satellite-Aircraft-Drogue Approach for Studying Estuarine Circulation and Shelf Waste Dispersion Proceedings Ocean 75 Conference, San Diego, 1974.
7. Klemas, V., Davis, G., Wang, H., Whelan, W., Monitoring Estuarine Circulation and Ocean Waste Dispersion Using Integrated Satellite-Aircraft-Drogue Approach, International Conference on Environmental Sensing and Assessment, Las Vegas, September 14-19, 1975.
8. Klemas, V., Remote Sensing of Wetlands Vegetation and Estuarine Water Properties, Proceedings Third International Estuarine Research Conference, Galveston, October 6-9, 1975. (Invited paper).
9. Eight reports on significant result to NTIS.

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J. REFERENCES

1. Klemas, V., "Application of LANDSAT-2 to the Management of Delaware's Marine and Wetland Resources" contract NAS5-20983 extension request to the National Aeronautics and Space Administration by the University of Delaware (March 31, 1976)
2. Klemas, V.; Bartlett, D. S., and Rogers R.; Coastal zone classification from satellite imagery, P. E. and R. S., v. 41, 3, 1975.
3. Rogers, R; Peacock, K. and Shah, N. - A technique for correcting ERTS data for solar and atmospheric effects - 3rd ERTS Symp. and NASA SP-351, Goddard S.C., Greenbelt, Md. 1973.
4. Bartlett, D. S. - Variability of wetland reflectance and its effect on automatic categorization of satellite imagery-unpubl. Thesis, 1976.
5. Klemas, V., Davis, G., Wang, H., Whalan, W., Tornatore, G., A Cost-Effective Satellite-Aircraft-Drogue Approach for Studying Estuarine Circulation and Shelf Waste Dispersion. Proceedings Ocean 75 Conference, San Diego, 1974.
6. Klemas, V. and others. Type II Progress Report, NASA Contract NAS5-20983, February 9, 1976.
7. Klemas, V. and others. Type II Progress Report, NASA Contract NAS5-20983, October 24, 1975.
8. U. S. Department of Commerce (1960), Tidal Current Charts--Delaware Bay River, Environmental Science Services Administration, Coast and Geodetic Survey, Second Edition.
9. Klemas, V., Otley, M., Philpot, W., Rogers, R., Correlation of Coastal Water Turbidity and Circulation with ERTS-1 and Skylab Imagery. Proceedings Ninth International Symposium on Remote Sensing of Environment, April 15-19, 1974, Ann Arbor, Michigan.

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